IN COMMON COUNCIL.

FEBRUARY 28th, 1831.

Mr. Townsend presented the following Communication from the Committee of the Lyceum of Natural History of the City of New York, in answer to an enquiry from Mr. Townsend on the Source, Quality and Purity of the Water on this Island, which was laid on the table and directed to be printed for the use of the members.

J. MORTON, Clerk.

New-York, February 17, 1831.

SIR,

The Common Council have taken into consideration the important subject of supplying the city with a pure and wholesome water. As one of the committee on that subject, I beg leave to enquire of the excellent institution over which you preside, and in whose valuable labours I feel a deeper interest from having been one of its founders, whether you have, in your researches, examined the chemical constitution of the springs of this island, the matters with which they are impregnated, and the effect which the geological stratifications of the Island or the vicinity of the sea, may have in deteriorating their qualities.

Any information in your possession on this important matter will be extremely acceptable at this moment, and it would give me great pleasure to communicate the same to the Common Council.

Very respectfully your ob't. servt.

P. S. TOWNSEND.

The President of Lyceum of Natural History.

Lyceum of Natural History, February 22, 1831.

To Assistant Alderman Townsend,

SIR,

The undersigned have been appointed a committee to reply to your letter of the 18th instant, addressed to the Lyceum of Natural History, in which you have requested some definite information as to the *source*, *quantity*, and *purity* of the water on this island. The very short space of time required for an answer will prevent us from entering into those minute details which you may have expected, and which the importance of the subject demands. Your communication embraces in fact a much wider field of enquiry, but we shall confine ourselves to those topics alone which are more immediately connected with the pursuits of our society.

The phenomenon presented by springs or wells of water have given rise to many intricate questions, exercising the ingenuity and often deranging the speculations of philosophers. It is only in more recent times when the position and nature of rocks have been attentively studied, that this subject has been freed from the mystery and embarrassment in which it was formerly involved. Almost every spring or well of water on the globe (it is now ascertained) must be studied by itself in order to understand thoroughly its source and all the circumstances connected with its overflow. It fortunately happens however that on this island, springs or wells of water are presented to us in the simplest form, and of these, we shall now proceed to treat.

1. *Of the source of all the Water on this Island.*

The first and most important consideration is the nature of the loose soil or earth on the surface, and the composition and arrangement of the rocks beneath upon which this earth rests.

This Island, as you are aware, consists (with the exception of a small portion near Kingsbridge) of a rock of uniform nature. Immediately upon this rock is a bed of sand which is of unequal thickness, and upon this sand and gravel the city is built.

The rock is known by geologists under the name of gneiss or stratified granite, and as it is among the lowest rocks ever found, it has been considered as the first created, and accordingly has been called a primordial or primitive rock. In whatever part of the world we dig, we may be sure, after passing through all other kinds of rock (of which there are about fifty in number) of arriving at last to a rock of the same nature with that which underlies this city. It freqently however happens that only a few rocks are found lying upon the gneiss or stratified granite, and in many places it rises to the surface not covered by any other rock whatever. Upon such a denuded or uncovered rock stands the city of New-York. The committee are not prepared to indicate the precise situation of the adjoining rocks, as the rivers conceals on each side their place of contact, and it would be requisite to enter into much geological detail to show their probable arrangement. With this preliminary explanation we are now prepared to enter upon the enquiry concerning the origin of the springs upon this island. The only source of fresh water is from the atmosphere from which it falls in the form of rain, hail and snow, having been previously carried up from the surface by evaporation. When the earthy and stony beds or strata are of a soft porous nature, and differ among themselves in their structure and composition, the rains soak through the more porous or spongy rocks until its further course downwards is finally arrested by the more compact ones. This is a matter of too common observation to be insisted upon, and explains why in our researches for water we are often compelled to dig to great depths, at the same time, an acquintance with the structure and composition of rocks should prevent us from perforating rocks, which from their very nature and position cannot be expected to furnish water. All the water which falls on this island is then first absorbed by the sand through which it trickles until it meets with the solid rock which it softens to the depth of a few feet, and then makes no farther progress. This sand overlying the rock, is the recipient of all the water which falls on the surface. It is in this sand that all our wells are sunk, and we accordingly find that where the bed of sand is not deep, water is met with (when any is present,) at only a few feet from the surface. This rock is also free from metallic veins. Such veins are however sometimes found, but they are of rare occurrence and inconsiderable in size. Their presence in a well sunk into this rock is always known by the taste and appearance of the water. The two wells recently sunk into the rock in the rear of the City-Hall are instances of this kind, and others of a similar nature might be adduced if necessary. It has been urged by some

persons that water must be found in our rock, because mines, some of which are in a primitive rock nearly resembling this, are often filled with water. This water upon examination will be found to proceed from the more porous rocks above, or when these rocks are wanting, from accidental fissures leading the water from above into the artificial cavities made by the miners. We have no data readily at hand to be enabled to state the amount of water raised from one of these mines, but it must be inconsiderable, when regarded as a source of supply for a population of 200,000 inhabitants. Even if it should be conceded that one of these mines furnished an abundant supply, it remains to be proved that our gneiss rock is penetrated with as numerous and as large mineral veins, and then it would be necessary to make excavations as extensive as in the mines alluded to. The *position* of rocks is also a matter of primary importance in reference to the subject of springs of water. By position is meant the manner in which rocks are arranged with respect to each other and among themselves. Thus, limestone of a particular kind, occurs in horizontal beds or strata, and many rocks are found nearly upright. The gneiss of this Island has its strata, nearly vertical or upright, and these are so closely united, that the separation is barely visible to the eye. It is not then from these crevices or partings that we are to expect a supply of water. We shall close our remarks on the nature of this rock, with the fact that it is free from those natural cavities observed in some other stony strata.

Let us now examine the nature of the earthly covering over the rock of this Island. We have said that this consists entirely of sand, and this may be verified over the whole Island. There are, however, at some places along the East River, extensive deposits of mud. At these places the rock has not been elevated to its usual height, and of course has been a convenient receptacle for this deposit. At Manhattan Island, there has been observed, first a deposit of sand, then a layer of mud, underneath this another sand bed, and lastly, the usual rock.— These facts are introduced here, (and many others might be cited) not as having any important bearing upon the question, but as exceptions to the general rule that the whole Island is covered by a bed of sand. We must again repeat, that all the water obtained from our wells is derived wholly and exclusively from the atmosphere We think it necessary to do this, as there is a very prevalent idea, that the salt water from our rivers penetrates through the sand and appears in our wells in the form of fresh water. Those who have adopted this opinion are not aware that by no process of straining or filtration, can salt water be rendered fresh. The saline ingredients are not like animal and vegetable matters which are merely suspended in the water; on the contrary, they are chemically combined with the water, and can only be separated from it by chemical processes. No chemical process which could produce this separation, is known to be going on under this Island.

This theory of infiltration has been supposed to be confirmed because on this Island, fresh water is obtained as soon as we dig to the level of the tide. This may be briefly explained. The sand bank resting upon the rock of this Island, is saturated or soaked to a certain distance from the rock with fresh water from the surface. This is surrounded on all sides by the heavy salt water, which acts as a barrier or dam, and hinders the fresh water from flowing off altogether. Hence at places near this barrier the wells although fresh, rise and fall with the tide; for when the tide falls, the fresh water thus hemmed in, must fall, because its area is diminished, and the fresh water in the well accordingly rises.

At places more remote from this barrier these effects are transmitted of course, so slowly, that before a change of tide could affect a distant well, another change of an opposite character would be in operation. The very fact that we are obliged to dig through a comparatively dry sand until we reach the tide level is a strong confirmation of the existence of this barrier. Instead then of supposing that our wells are furnished from the river, it would be more correct to say that much of our fresh water is carried off into the river. The phenomena of fresh water springs in the beds of rivers are susceptible of easy explanation, as they occur in the neighborhood of this Island.

2. *Of the Quantity of Water on this Island.*

The result of a series of meteorological observations gives us annually a fall of water equal to 36 inches, and the surface of the Island is about 12,000 acres. This gives us an annual amount of eleven thousand seven hundred and thirty millions six hundred and twelve thousand gallons. But when it is proposed to ascertain the available amount of water, we must make the following deductions,

1. The loss by evaporation.
2. That portion which falls upon naked rocks, or into natural channels on the surface, and is carried off into the river.
3. That portion which is prevented from penetrating the surface by the intervention of artificial means, such as pavements and dwellings.
4. And lastly, we must deduct all that portion which, although absorbed by the sand, is not retained because it lies above the tide.

It is then evidently, in the present state of our knowledge, a matter of extreme difficulty, to offer any accurate estimate of the quantity of water, which (after making these deductions) would remain for the use of the city.

This water, where the nature of the surface permits, forms ponds or basins of water, whose size depends upon the extent

of surface of the ground, which slopes towards these natural reservoirs.

Such reservoirs exist in various parts of the island, but they are too limited in their drainage surface to be recommended as capable of affording any adequate supply. In the natural course of events they would be surrounded by streets and dwellings, which would lessen the quantity, and seriously impair the quality of their water. This may diminish the regret which has often been inconsiderately expressed, since one of the largest of these natural basins, (the Collect,) has been filled up and built upon. At the period when this was open, there was no city above it; and the surface was in its natural condition for imbibing and conducting the water to this basin. At present, pavements and dwellings oppose a barrier to the absorption of water, and the levelling of the hills have greatly affected the quantity and direction of its drainage.

We come now to that part of your letter requesting information as to the purity of our waters, a subject upon which there is a wide difference of opinion. This, however, must always be the case where habitual use, local prejudice and the fallacious criterion of taste, is substituted for the unerring results of chemical analysis.

3. *Of the Purity of the New York Waters.*

All waters, it is well known, which are not decidedly of a mineral character, are divided into two classes, *hard* and *soft*. With the latter we have nothing to do in the present communication, as none of it occurs in the thickly settled parts of the island. Hard waters are such as contain a sensible quantity of foreign ingredients, the chief of which are Carb. of Lime, Sulph. Lime, (or Plaster of Paris,) Mur. Sod. (or Common Salt,) Mur. Magnes. Iron, and Extractive or animal and vegetable matter. We accordingly find that all the water in the city contains these, and occasionally other ingredients. For the following analysis of pump waters in various parts of the city, the Committee are indebted to one of its members. When it is recollected that the hardest spring water seldom contains so much as one thousandth part of its weight of any foreign body in solution, it would seem that the term, mineral water, would be a more correct designation for the ordinary waters of this city.

Results of analysis of various mineral and pump waters in the city of New-York, by George Chilton, Chemist:—

No. 1. A pint of water yielded 10 grains of solid matter, consisting of

Mur. Magnes. - - -	3 50
Mur. Sod. - - - -	4
Sulph. Lime, - - -	0 25
Carb. Lime and Magnesia, -	1 25

Carb. Potass and Extractive,	0 75
Loss, - - - - - -	0 25
Total,	10

No. 3. A pint yielded 7 grains of dry residue, consisting of

Mur. Magnes. - - -	2
Mur. Soda, - - - -	2
Sulph. Lime, - - -	1
Carb. Lime and Magnes. -	1 25
Extractive Matter and Loss, -	75
Total,	7

No. 3. A pint yielded 4 50 grains, composed of

Mur. Soda, - - - -	1
Mur. Magnes. - - -	2
Carb. Lime, - - -	1
Sulph. Lime and Extractive,	0 50
Total,	4 50

No. 4. A pint yielded about 4 grains, composed of

Mur. Lime, Mag. and Extractive,	1 80
Mur. Soda, - - - -	1
Sulph. Lime, - - -	0 25
Carb. Lime, - - -	1
Total,	4 05

No. 5, Contained Sulph. and Mur. Lime, with a little coloring matter.

No. 6, Contained Sulph. Lime, Sulph. and Mur. Soda, with Extractive.

No. 7, Was not disturbed by Nitrate of Silver, Sulph. Silver, Ammonia, nor Barytic Salts.

From whence then are derived those foreign ingredients? It has been already stated, that the sand bed of this island may be regarded as a filter or sponge, which, under ordinary circumstances is saturated with fresh water from the atmosphere. If this spongy mass was originally free itself from any mineral impregnations, and its surface always open, the water would of course remain pure for any definite period. When this filter itself contains foreign ingredients, and the free transmission of pure water is prevented, its quality must be impaired. From accurate data these obstacles to the transmission of water from the surface, by dwellings and pavements, are estimated to carry off into the river nearly one half of the water which falls from the atmosphere. In the neighborhood of large open squares, it is consequently observed that the wells are more pure, but

they must sooner or later partake of the same deterioration.—The water in the immediate vicinity of the park, although very impure, is nevertheless of a better kind than that from more distant wells; and we have been informed that the well of the Manhattan Company is mostly supplied from that quarter. It has been observed, also, that the vicinity of grave yards communicates a ropy appearance to the water; and the water from such wells becomes, in warm weather, very offensive in the course of a few hours. If the above facts be well founded, we must naturally anticipate a deterioration of our waters, proceeding *pari passu*, with the increase of the city; and we accordingly find this to be the case. Until within the last few years the water on the elevated ground in Broadway was considered to be the best in the city. In the progress of improvement, this water is now hard and unpalatable. Indeed, we know of families living above Broome-street, in Broadway, who are now supplied throughout the year by water carts from the country; and in the direction of Laurens-street, we have been informed that this foreign supply is required still farther to the north of Broome-street. But we are now to allude to another cause, which must greatly impair the purity of our waters:—Into the sand bank, underlying the city, are daily deposited quantities of excrementious matter, which, were it not susceptible of demonstration, would appear almost incredible. With our present population, there is put into this sand about 100 tons of excrement every 24 hours. In these deposits we may find all the ingredients detected by analysis, and which destroy the purity of our waters. But in this estimate we do not include an equal amount of urine, for the following reason:—This liquid, when *stale* or *putrid*, has the remarkable property of precipitating the earthy salts from their solution, or in other words, it makes hard waters soft. Although the fastidious may revolt from the use of water thus sweetened to our palate, it is perhaps fortunate that this mixture is daily taking place, for otherwise the water of this city would become, in a much shorter space of time than it actually does, utterly unfit for domestic purposes. We cannot take leave of this part of the subject without adverting to the various and contradictory opinions which have been expressed on the purity of our waters. We must impute to long use, and the influence of habit, the opinion that our water is sufficiently pure for domestic purposes. We have known our citizens, upon going into the country, express a marked disrelish for pure spring water. The popular expression on such occasions is, "This water is like wind—there is nothing substantial in it; nothing to bite upon." This powerful influence of habit is exemplified even among animals. At one of our watering places, (Saratoga,) cattle have been observed to prefer the strongest mineral water known, to that derived from a pure source. The coldness of our pump waters is another cause which conceals their impurities when swallowed.

This may be tested by allowing it to stand until it has acquired the ordinary summer temperature: its various ingredients become then manifest, palpable. These impurities are not caused by the additional heat; they exist at all times in the water; their presence is only disguised for the moment by its coldness, and its injurious properties are in no wise diminished.

Your enquiry as to the effects of impure water upon the human system, falls more properly within the province of the medical philosopher than the naturalist; we do not, therefore, feel ourselves called upon in this place to enter upon this subject farther than to state, that in several diseases, such as dyspepsia, and those bowel complaints of children, which carry off so many annually, the cure is retarded by the daily use of bad water. In the latter disease, in particular, the mode of cure often resorted to, is a change of air, which is supposed to be the chief agent in removing the disease. It is within the knowledge of some of the Committee, that the use of pure water alone, without removal, has produced an almost immediate and beneficial change.

From all which has been previously stated, you will learn that it is the unanimous opinion of the Committee, *that no adequate supply of good or wholesome water can be obtained on this Island, for the wants of a large and rapidly increasing city like New York.* The various preforations which have been made, in the absence of all other proof, would sufficiently establish this position. These have been undertaken without any acquaintance with those immutable laws of nature, which regulate the position of rocks, and their utter uselessness is now sufficiently obvious. They may be carried to any assignable depth in this rock, and when completed will be merely reservoirs to receive the drainage from above.

If this communication had not already extended beyond the limits originally proposed, we should have shown that there is no similarity whatever, between the situation of London and New York, in reference to the earthy and stony strata upon which they are respectively situated. This would have been the more desirable, as many otherwise intelligent men have supposed, that because water is obtained at London by digging several hundred feet through a stiff clay, we may therefore obtain it in this city by digging still deeper into the bosom of a compact primitive rock. We do not feel it to be within our province to point out the quarter from whence the supply of water should be obtained, but it is clear that we cannot look for it on this island. Several members of our Society have examined the manner in which other cities in Europe and South America are supplied, and would, in their individual capacity cheerfully give all the information required, upon a subject which interests alike the rich and the poor, those who reside in the lower wards and the inhabitants of the more recently built portion of the city. From whatever quarter the supply is ob-

tained, it must be from places beyond all possibility of ever being surrounded by a dense population. It must also be procured in sufficient abundance to provide for the wants, not only of the present, but future generations.

We are, Sir, very respectfully,

Your obedient servents,

JOSEPH DELAFIELD,
J. E. DEKAY,
JOHN TORREY,
GEORGE CHILTON,
T. DEWEY,
JER'H. VAN RENSSELAER.